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ORIGINAL ARTICLE

Prospective Associations Between Home Practice and Depressive Symptoms in Mindfulness-Based Cognitive Therapy for Recurrent Depression: A 15 Months Follow-Up Study

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Abstract

Background Home practice is considered a key element in increasing treatment effectiveness of Mindfulness-Based Cognitive Therapy (MBCT) for depression. However, long-term longitudinal research into the associations between home practice and depression outcomes is scarce. The current study examined the prospective associations between the extent of formal home practice and subsequent depression severity during 15 months of follow-up.

Methods Data from two randomized-controlled trials on MBCT for recurrent depression were used ($n = 200$). Depressive symptoms were assessed at 3-month intervals: 0 (baseline), 3 (posttreatment), 6, 9, 12, and 15 months. Formal home practice frequency was calculated for each 3-month period. Autoregressive latent trajectory (ALT) modelling was applied.

Results Participants practiced formal exercises on 57% ($SD = 0.22$, range 0–1) of the days during MBCT, equivalent to an average of 4 days per week, which showed a rapid decline after MBCT. The level of depressive symptoms did not change over the full study period. A small positive association was found between formal home practice frequency during each three-month period on subsequent depressive symptoms, but sensitivity analyses did not confirm this. More robust, a small negative association was found between levels of depressive symptoms at each measurement point and formal home practice frequency during the subsequent three-month periods.

Conclusions The hypothesis that more frequent home practice would lead to reductions in depressive symptoms was not confirmed in the current study. Rather, it seems that patients with higher levels of depression may subsequently practice less frequently at home. The interplay between home practice and outcome might not be as straightforward as expected. However, these results are preliminary and should be replicated first before recommendations for clinical practice can be formulated.

Keywords Mindfulness-based cognitive therapy · Mindfulness · Recurrent depression · Home-practice · Autoregressive latent trajectory modelling

Introduction

Major depressive disorder (MDD) is the most common form of depressive disorders, and the leading cause of disease burden worldwide (American Psychiatric Association 2013; World Health Organization 2017). MDD often runs a chronic and recurrent course (Richards 2011). Many patients experience residual depressive symptoms, which are a predictor of relapse/recurrence (Buckman et al. 2018; Nierenberg 2015). Aside from antidepressant medication, numerous psychological interventions have been developed for MDD, among which Mindfulness-Based Cognitive Therapy (MBCT; Segal et al. 2002). Accumulating evidence suggests that MBCT is effective in both reducing relapse/recurrence and depressive symptoms in recurrently depressed patients (Kuyken et al. 2016; Strauss et al. 2014).

MBCT is a group-based training, consisting of 8 weekly sessions, and includes both mindfulness meditation and cognitive behavioural therapy (Segal et al. 2012). Mindfulness is frequently defined as the awareness that emerges by

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purposefully paying attention to the present experiences with a non-judgmental stance (Kabat-Zinn 1994). It is also considered a skill that can be further developed through regular practice (Segal et al. 2012; Tang et al. 2015). Therefore, home practice is considered an essential element in MBCT (Alsubaie et al. 2017). Formal home practice, as part of the MBCT protocol, takes about 45 min a day and includes practices such as the body scan, sitting meditation, and mindful movement. In addition, various short informal home exercises are given involving the cultivation of mindfulness in routine daily life activities (Segal et al. 2012).

Previous research suggests that more formal home practice during mindfulness-based interventions (MBIs) is associated with better posttreatment outcomes. A recent systematic review and meta-analysis, including over 1400 clinical and non-clinical participants (Parsons et al. 2017), found a pooled estimate for participants' formal home practice of 64% of the assigned amount (i.e., percentage of minutes/day or days/week) during MBCT/MBSR. Twenty-eight studies investigated the association between formal home practice and posttreatment outcomes of which 15 were randomized controlled trials (RCTs). A small to moderate significant association between formal home practice during MBCT/MBSR and positive posttreatment outcomes was found ($n = 898$; $r = 0.26$, 95% CI 0.19–0.34). This was confirmed by the analysis restricted to RCTs only ($r = 0.26$, 95% CI 0.14–0.38, $z = 4.21$, $p < .001$). However, most studies investigated MBSR rather than MBCT and only a few studies investigated the associations between formal home practice and outcome of MBCT in patients with recurrent depression.

Research into the effects of MBCT formal home practice on depression at long-term outcome is limited. Crane et al. (2014) investigated the effect of formal home practice in MBCT on relapse/recurrence depression in 99 recurrently depressed patients during a 12-month follow-up period, and found a significant effect of average daily minutes of formal home practice on the risk of relapse to major depression (HR 0.97, CI 0.947–0.995). In contrast, Bondolfi et al. (2010) did not find significant associations of formal home practice frequency during and after MBCT, up to 12 months of follow-up, with risk of relapse/recurrence in patients with recurrent depression. However, they suggested that these non-significant findings might be due to retrospective measurements of formal home practice, and the small sample size ($n = 26$), which resulted in limited statistical power.

Furthermore, higher levels of depressive symptomatology might act as a barrier to carry out home practices. One could experience more difficult or aversive thoughts and feelings (Beck and Clark 1997), and become more preoccupied by them, for example due to attentional biases associated with depression (Mogg et al. 1995) and increased rumination (Whitmer and Gotlib 2013). As people typically show a tendency to avoid or suppress unpleasant experiences (Aldao et al. 2010), and depressive symptomatology may further add motivational and concentration difficulties (Keller et al. 2019; Ravizza and Delgado 2014), it seems reasonable to expect a negative influence on home practice. To date, little is known about the possibility of such a reverse effect. To investigate the course and possible mutual relationships between home practice and depression outcomes, multiple assessments of both constructs over time, preferably also after the intervention period, and the use of advanced analytical techniques are needed.

Therefore, the current study examined the prospective associations between multiple assessments of formal home practice frequency and depressive symptoms over a period of 15 months in MBCT for recurrent depression. The autoregressive latent trajectory (ALT) modelling technique used in this study allows an investigation of effects of formal home practice frequency on subsequent depressive symptoms and vice versa while at the same time accounting for the overall trajectories for both variables across the entire study period. Therefore, ALT is perceived as highly suitable for analyzing dynamic processes. We hypothesized that more formal home practice would be associated with subsequent less depressive symptoms. In addition, we hypothesized that more depressive symptoms would be associated with less subsequent formal home practice frequency.

Methods

Design

This study was based on data from the MOMENT study which consists of two RCTs that investigated the effectiveness of MBCT, maintenance antidepressant medication (mADM) and the combination of both to prevent relapse/recurrence in patients with recurrent depression in remission during 15 months of follow-up (Huijbers et al. 2015, 2016). The first RCT was a non-inferiority trial comparing the combination of MBCT and mADM with MBCT followed by discontinuation of mADM (Huijbers et al. 2016). The second RCT was a superiority trial comparing the combination of MBCT and mADM with mADM alone (Huijbers et al. 2015). The current study used data from the subset of participants ($n = 282$) allocated to MBCT (with or without tapering off mADM) in both trials. The protocol has been approved by the Medical Ethics Committee of Arnhem-Nijmegen (CMO, no. 2008/242; Huijbers et al. 2012).

Participants

Patients with recurrent depression in (partial) remission ($N = 317$) were recruited between September 2009 and January 2012 at secondary and tertiary psychiatric outpatient

clinics across the Netherlands. Inclusion criteria were: (a) ≥ three prior major depressive episodes according to the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association 2000) assessed by the Structured Clinical Interview for DSM disorders I (SCID-I; First, Gibbon et al. 1996); (b) ≥ 6 months on a stable dose of antidepressant medication; (c) full or partial remission, not meeting the criteria for a depressive episode using the SCID-I; (d) native Dutch speaking. Exclusion criteria were: bipolar disorder, psychotic disorder, neurological disorder, somatic disorder, current alcohol and/or drug dependency, high dose of benzodiazepines, electric convulsive therapy within the past three months, previous MBCT/MBSR, and current psychotherapy more than once per three weeks. All participants were included only after written informed consent had been obtained.

Intervention

MBCT was delivered largely according to the protocol of Segal et al. (2002, 2012). The training was delivered in groups of 8–12 participants during eight weekly sessions of 2.5 h and one day of silent practice between the 6th and 7th session. MBCT home practice included daily formal home practices using a compact disk (CD) for 45 min (e.g., the body scan, sitting, walking meditation and mindful movement) and daily informal exercises such as bringing present-moment awareness in everyday activities. Videotapes were available for 15 teachers and examined with the Mindfulness-Based Interventions Teaching Assessment Criteria (MBI:TAC; Crane et al. 2013). The teacher competency ratings showed that none of the teachers were incompetent, two teachers (13%) were characterised as beginners, six (40%) as advanced beginners, four (27%) as competent, three (20%) as proficient, and none as advanced. The mean teacher competency score was 3.5 (SD = 0.9, range 2.0–5.2). Of these teachers, 8 were psychologists, 3 occupational therapists, 3 psychiatric nurses and 1 psychiatrist. Their mean clinical experience was 21 years (SD = 6.5, range 11.5–31.0), with a mean of 23 MBCT courses taught (SD = 16, range 6–60). Teachers' personal experience with meditation included on average 9 years of personal meditation practice (SD = 8.0, range 3.0–35.0), with a mean amount of 57 days spent in retreat (SD = 95, range 0–282), and mean meditation practice of 4.3 h a week (SD = 3.3, range 0.5–14.0).

Measures

Depression severity was assessed with the Dutch version of the Inventory of Depressive Symptomatology-Clinician rated (IDS-C; Akkerhuis 1997) at 3-month intervals: 0 (baseline), 3 (posttreatment), 6, 9, 12, and 15 months. These measurement points are referred to as *t0*, *t3*, *t6*, *t9*, *t12*, and *t15*, see Fig. 1. The IDS-C consists of 30 multiple choice questions on a 4-point Likert-scale assessing depressive symptoms over the last seven days designated by the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association 2000). The IDS-C is scored by summing responses of 28 out of 30 items (two sets of items are mutually exclusive) to obtain a total score ranging from 0 to 84. Higher scores indicate greater symptom severity. The internal consistency of the current study was good to excellent at all measurement points (α range 0.86–0.91).

Home practice frequency was assessed using monthly calendars, specifically designed for this study, on which participants could indicate via tick boxes whether or not they had completed their assigned daily formal home practice (i.e., body scan, sitting meditation, mindful walking or movement exercises). Data on formal home practice frequency was collected across 15 months by asking participants to return their calendars each month using a return postage envelope. The average percentage of days practiced per three months was calculated (1–3, 4–6, 7–9, 10–12, and 13–15 months). These measurement points are referred to as *t1.5*, *t4.5*, *t7.5*, *t10.5*, and *t13.5*. The time period of formal home practice applies to the period between two assessments of depressive symptoms, see Fig. 1.

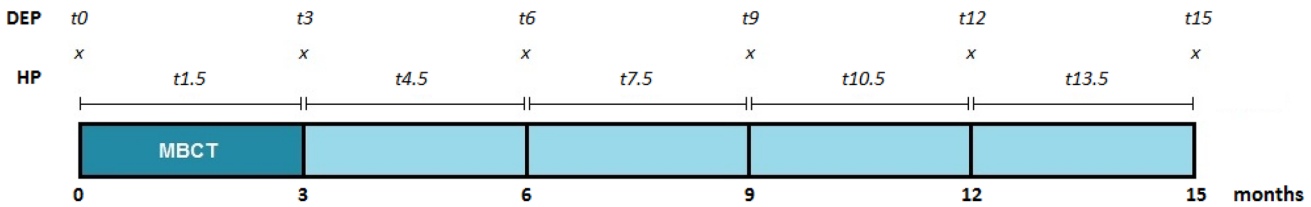

Fig. 1 Schematic overview of the measurement points of depressive symptoms (DEP) and formal home practice (HP). *t0* = baseline; *t1.5* = 1–3 months; *t3* = 3 months; *t4.5* = 4–6 months; *t6* = 6 months; *t7.5* = 7–9 months; *t9* = 9 months; *t10.5* = 10–12 months; *t12* = 12 months; *t13.5* = 13–15 months; and *t15* = 15 months of follow-up

Statistical Analyses

Home Practice

Given the fact that participants did hand in monthly calendars indicating that they did not carry out their formal home practices, we assumed that there was not a huge barrier in reporting non-adherence to formal home practice. When a calendar was missing however, we did not know whether a participant did or did not practiced during that month. Therefore, in order to provide a more accurate estimate of average formal home practice frequency in each 3-monthly period, person mean imputation was applied in case one out of three monthly calendars was missing by using the data of the other two calendars for that time period. When two or three calendars were missing for a certain period, this was coded as a missing value for that period. In addition, participants with less than two out of three monthly calendars for each three-month period ($n = 82$) were excluded -as these participants had missing values for each period.

ALT Modelling Technique

To investigate the prospective associations between formal home practice and depressive symptoms during 15 months of follow-up, the Autoregressive Latent Trajectory (ALT) modelling technique was used, which combines a Latent Trajectory Model (LTM) with an AutoRegressive (AR) model. The LTM model allows a different overall trajectory per participant as marked by a different (subject-specific) intercept and slope. The intercept displays a general level of a variable. The intercept variance represents differences in general levels between participants. The slope can be interpreted as an overall magnitude of change (positive or negative) of a variable over the full study period (15 months). Its variance depicts inter-individual differences in the magnitude of change. Interrelationships between two variables from measurement-to-measurement are not captured by a LTM. AR models do investigate associations between two different variables across subsequent measurement points, so called cross-lagged (CL) effects, while taking the effect of the prior value of the same variable on the current value into account. However, when not accounting for the overall trajectories of the variables over time, spurious CL effects might appear while they essentially do not exist (Voelkle 2008). Hence, by combining the LTM with an AR model into an ALT model it is possible to properly interpret CL effects while controlling for overall trajectories. Several bivariate structural equation models (SEM) were fitted, following the recommendations of Bollen and Curran (2004), which led to a final bivariate ALT model. When fitting the SEM models, robust maximum likelihood (MLR; Satorra and Bentler 2010) was employed in order to account for skewed variables, see Table 2. For the model building steps of the various bivariate SEM models that were fit, see supplementary material.

Model Fit

Several fit indices were used to evaluate model fit: (1) Chi-square, χ^2/df, values close to 1 were considered good, values between 2 and 3 as acceptable and less than 2 as preferable fit (Carmines and McIver 1981; Marsh and Hocevar 1985); (2) The Tucker-Lewis index (Tucker and Lewis 1973) and Comparative Fit Index (CFI; Bentler 1990) of which values higher than 0.90 were considered an adequate and higher than 0.95 a very good fit (Bollen 1989; Hu and Bentler 1999); (3) Root Mean Square Error of Approximation (RMSEA; Steiger 1998) of which values below 0.07 were indicative of good fit, while for Standardized Root Mean Square Residual values below 0.08 were adequate and below 0.05 were considered good (SRMR; Hooper et al. 2008). Model comparisons were evaluated with the Satorra-Bentler scaled chi-square difference test for nested models (Satorra and Bentler 2001, 2010), which takes into account that the MLR estimator was used to fit the SEM models (see above). In case a significant difference between two models existed, the more complex model (i.e., the model with less degrees of freedom) was retained, otherwise the simpler model was chosen. For non-nested models, the model with the lowest Bayesian information criterion (BIC; Raftery 1995) was favoured in which differences between 2–6 points were considered as small, 6–10 points as medium strong and > 10 points as very strong evidence of differences in model fit. Differences of ≤ 2 on the BIC indicated that both models fitted the data equally well and the most parsimonious model was favoured (Raftery 1995).

Sensitivity Analyses

At first, the final bivariate ALT model was fitted including a zero imputed variable for formal home practice (i.e., in which no data on formal home practice was interpreted as not having practiced at all) among the same participants included in the current study ($n = 200$). Second, the final bivariate ALT model including a zero imputed variable for formal home practice was fitted among all participants who were allocated to MBCT ($n = 282$). The results of both sensitivity analyses were compared to the results of the final bivariate ALT model of the current study ($n = 200$) including the original (mean imputed) formal home practice variable.

Computational Note

Descriptive analyses were performed using IBM SPSS Statistics version 22.0 (IBM Corporation 2013). The structural equation modelling analyses were carried out by using Mplus version 6.11 (Muthén and Muthén 1998/2011). Probability values lower than 0.05 (two-tailed) were considered significant for all analyses.

Results

Descriptives

There were no baseline differences in demographic and clinical characteristics between participants included and excluded from the primary analysis of the current study, see Table 1. Figure 2 portrays the overall course of formal home practice across 15 months of follow-up. Participants practiced on average 57% of the days during MBCT ($SD = 0.22$, range 0–1) which equals an average of 4 days a week. A rapid decline of formal home practice frequency was found during the follow-up periods, where formal home practice reached a plateau at 21% of the available number of days to practice, equivalent to an average of about 1.5 days a week. Depressive symptoms showed a stable course over time. Table 2 presents detailed descriptives and correlations of the variables under study.

Bivariate ALT Modelling

In Table 3 the model fit indices are presented of the consecutive bivariate SEM models that were fit. For detailed results of the bivariate model building process, see Supplementary Material. The bivariate ALT-model that demonstrated the best fit had no slope variance and intercept variance for formal home practice, equal AR effects over time for formal home practice, and equality constraints of CL effects over time for both formal home practice to subsequent depressive symptoms and vice versa. This model provided a very good model fit ($\chi^2 = 49.698$, $df = 45$, $p = .292$; CFI = 0.993; TLI = 0.992; RMSEA = 0.023, SRMR = 0.057).

Figure 3 graphically displays the standardized parameter estimates of the final bivariate ALT model. The overall trajectory of formal home practice indicated that, on average, formal home practice frequency decreased over time; i.e., a negative and significant slope parameter ($\mu_{\beta HP} = -0.530$, $s.e. = 0.023$, $p < .001$), accompanied by a positive and

Table 1 Baseline demographic and clinical characteristics of participants included versus excluded from the current study: means (*SD*) and frequencies (%)

Variable	Included ($n = 200$)	Excluded ($n = 82$)	Statistics[b]
Age (in years)	51.10 (10.56)	48.96 (12.11)	$t(280) = -1.48$, $p = .14$
Gender			$\chi^2(1) = 0.05$, $p = .82$
Male	63 (31.5%)	27 (32.9%)	
Female	137 (68.5%)	55 (67.1%)	
Educational level			$\chi^2(2) = 0.08$, $p = .96$
Low	15 (7.5%)	6 (7.3%)	
Middle	56 (28.0%)	20 (24.4%)	
High	124 (62.0%)	48 (58.5%)	
Missing	5 (2.5%)	8 (9.8%)	
Marital status			$\chi^2(3) = 2.96$, $p = .40$
Single	44 (22.0%)	22 (26.8%)	
Married/cohabiting	123 (61.5%)	38 (46.4%)	
Divorced	27 (13.5%)	12 (14.6%)	
Widowed	3 (1.5%)	2 (2.4%)	
Missing	3 (1.5%)	8 (9.8%)	
Employment			$\chi^2(1) = 1.53$, $p = .22$
Yes	132 (66.0%)	48 (58.5%)	
No	67 (33.5%)	34 (41.5%)	
Missing	1 (0.5%)	0 (0.0%)	
Age of onset	25.27 (11.63)	23.89 (11.46)	$t(271) = -0.90$, $p = .37$
Prior depressive episodes	5.84 (4.44)	6.60 (7.68)	$t(103.97) = 0.84$, $p = .40$
Depressive symptoms[a]	12.70 (9.94)	12.43 (10.40)	$t(280) = -0.21$, $p = .84$

[a]Assessed with the Inventory of Depressive Symptomatology-Clinician rated (IDS-C; Akkerhuis 1997)

[b]Due to missing values the degrees of freedom differ between the analyses

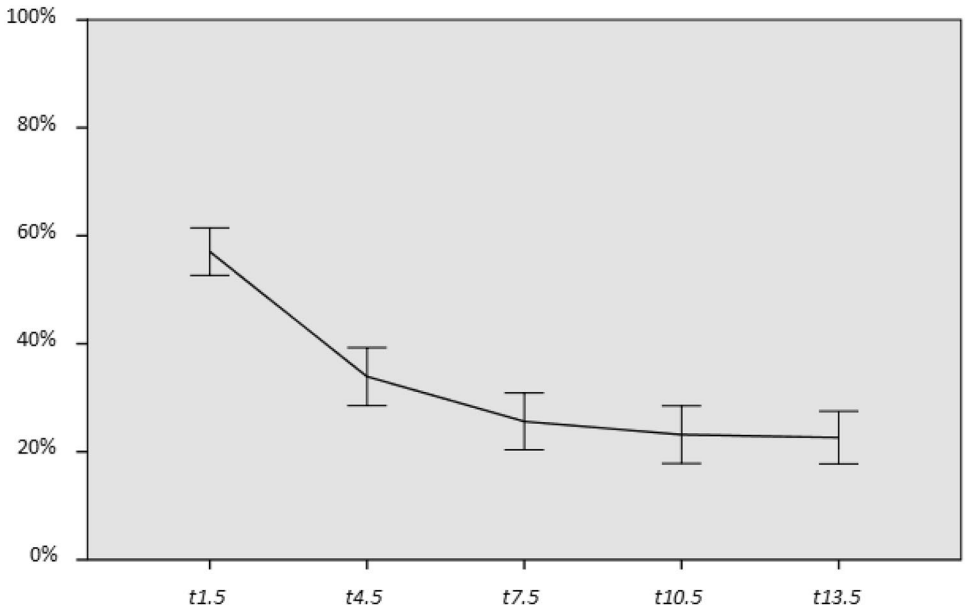

Fig. 2 The overall course of formal home practice across the full study period (15 months). The x-axis represents time in which *t1.5* = 1–3 months, *t4.5* = 4–6 months, *t7.5* = 7–9 months, *t10.5* = 10–12 months, and *t13.5* = 13–15 months of follow-up. The y-axis represents the average percentage of days that participants adhered to the assigned daily formal home practice

Table 2 Correlations between formal home practice (HP) and depressive symptoms (DEP) and their descriptives

	Formal home practice					Depressive symptoms					
	t1.5	*t4.5*	*t7.5*	*t10.5*	*t13.5*	*t0*	*t3*	*t6*	*t9*	*t12*	*t15*
HP *t1.5*	1										
HP *t4.5*	0.71**	1									
HP *t7.5*	0.55**	0.81**	1								
HP *t10.5*	0.55**	0.67**	0.77**	1							
HP *t13.5*	0.53**	0.57**	0.64**	0.76**	1						
DEP *t0*	− 0.10	− 0.10	− 0.03	− 0.07	− 0.13	1					
DEP *t3*	− 0.17**	− 0.10	− 0.04	− 0.09	− 0.09	0.47**	1				
DEP *t6*	0.11	0.11	0.04	0.06	0.03	0.37**	0.44**	1			
DEP *t9*	0.08	0.06	0.10	− 0.006	− 0.07	0.47**	0.39**	0.48**	1		
DEP *t12*	− 0.09	− 0.15	− 0.10	0.03	− 0.21*	0.46**	0.48**	0.42**	0.51**	1	
DEP *t15*	0.07	− 0.002	0.005	0.02	− 0.04	0.38**	0.36**	0.49**	0.54**	0.56**	1
Mean	0.57	0.32	0.24	0.21	0.22	12.70	13.39	14.13	13.80	13.77	12.44
Standard deviation	0.22	0.02	0.02	0.02	0.02	9.94	11.34	11.31	12.21	13.01	11.72
Kurtosis	− 0.37	− 0.15	0.85	1.76	0.80	0.55	0.53	0.64	2.15	0.69	1.00
Skewness	− 0.17	0.76	1.27	1.57	1.24	0.97	1.04	0.95	1.38	1.10	1.20

*$p < .050$, **$p < .010$

significant intercept parameter ($\mu_{\alpha HP} = 0.586$, *s.e.* = 0.017, $p < .001$). The variance of the intercept and slope factor of formal home practice could be set to 0, meaning that there was no significant difference between participants in their general formal home practice frequency level nor in their decline of formal home practice frequency over time. The intercept factor and the first measurement point of depressive symptoms were positive and significant ($\mu_{\alpha DEP} = 10.261$, *s.e.* = 1.866, $p < .001$; $\mu_{DEP(t0)} = 12.700$, *s.e.* = 0.701, $p < .001$) and positively correlated with each other ($r = 0.644$, *s.e.* = 0.132, $p < .001$). The variance of the intercept factor of depressive symptoms was non-significant ($\sigma_{\alpha DEP} = 33.291$, *s.e.* = 32.220, $p = .301$), while the variance of the first measurement point of depressive symptoms was positive and significant ($\sigma_{DEP(t0)} = 98.320$, *s.e.* = 10.995, $p < .001$). This indicates that participants did not differ in their general level, but did differ in their baseline levels of depressive symptoms. The slope of depressive symptoms was not correlated with both the first measurement ($p = .275$) and the intercept factor of depressive symptoms ($p = .498$). Both the slope factor of depressive symptoms and its variance were non-significant ($p = .075$,

Table 3 Model fit indices for the bivariate autoregressive (AR), latent trajectory models (LTM) and autoregressive latent trajectory (ALT) models for formal home practice (HP) and depressive symptoms (DEP)

Formal home practice [a] and depressive symptoms [b]		χ^2 (*df*)	CM	$\Delta\chi^2$ (*df*)	CFI	TLI	RMSEA	SRMR	BIC
1	AR model	102.035 (*36*)***			0.907	0.859	0.096	0.104	7683.834
2	LTM model	108.832 (*49*)***			0.916	0.906	0.078	0.072	7609.851
3	ALT—full model	22.274 (*25*)^{ns}			1.000	1.008	< .001	0.028	7652.367
4	ALT—LTM model	103.220 (*44*)***	*3*	71.380 (*19*)***	0.917	0.896	0.082	0.071	7631.041
5	ALT—no slope variance DEP	35.186 (*30*)^{ns}	*3*	12.155 (*5*)*	0.993	0.987	0.029	0.038	7639.300
6	ALT—no slope on DEP	37.413 (*31*)^{ns}	*3*	14.138 (*6*)*	0.991	0.984	0.032	0.041	7636.064
7	ALT—no slope variance HP	28.635 (*30*)^{ns}	*3*	6.485 (*5*)^{ns}	1.000	1.004	< .001	0.029	7634.182
8	ALT7—no slope on HP	231.403 (*34*)***	*7*	164.776 (*4*)***	0.723	0.552	0.170	0.290	7830.822
9	ALT7—AR constraints for FHP	33.523 (*33*)^{ns}	*7*	4.609 (*3*)^{ns}	0.999	0.999	0.009	0.041	7623.172
10	ALT9—AR constraints for DEP	44.696 (*37*)^{ns}	*9*	9.643 (*4*)*	0.989	0.984	0.032	0.050	7612.927
11	ALT9—CL constraints for DEP > HP	38.202 (*37*)^{ns}	*9*	4.569 (*4*)^{ns}	0.998	0.997	0.013	0.044	7606.357
12	ALT11—CL constraints for HP > DEP	46.685 (*41*)^{ns}	*11*	7.787 (*4*)^{ns}	0.992	0.989	0.026	0.056	7594.144
13	**ALT12—no intercept variance HP** [c]	**49.698 (45)^{ns}**	***12***	**3.093 (4)^{ns}**	**0.993**	**0.992**	**0.023**	**0.057**	**7577.015**

HP formal home practice, *DEP* depressive symptoms χ^2 Satorra–Bentler scaled Chi-square difference test, *df* degrees of freedom, $\Delta\chi^2$ Chi-square difference test, *CM* comparison model in the $\Delta\chi^2$, *CFI* comparative fit index, *TLI* Tucker–Lewis index, *RMSEA* root-mean-square error of approximation, *SRMR* standardized root mean square residual, *BIC* Bayesian information criterion. The final model is shown in bold

[a]Including free slope parameter estimates (0, *, *, *, 1)

[b]Including linear slope parameter estimates (0, 1, 2, 3, 4) and predetermined specification

[c]Due to a non-significant (small) negative intercept variance of formal home practice in the previous model

$^{ns}p \geq .050$, $^{*}p < .050$, $^{**}p < .010$, $^{***}p < .001$

respectively $p = .086$), which means that, in general, over the full study period, no significant increase or decrease in depressive symptoms was found, with this being true for all participants.

Looking at measurement-to-measurement effects, the AR paths for formal home practice were equally strong and statistically significant across all measurement points ($\rho\text{AR}(1)_{\text{HP}} = 0.810$, *s.e.* = 0.036, $p < .001$), inferring that individual differences in formal home practice was stable from one measurement to the next. Autoregressive effects were not present for depressive symptoms, apart from the period between 12 and 15 months. With regard to the CL effects, which are equal over time, higher average percentages of formal home practice frequency over each three-month period, predicted subsequent higher levels of depressive symptoms ($b_{\text{HP}(t\text{-}1.5),\ \text{DEP}(t1)} = 3.298$, *s.e.* = 1.632, $p = .043$). Vice versa, higher levels of depressive symptoms at each assessment predicted, on average, less formal home practice frequency across the subsequent three-month periods ($b_{\text{DEP}(t\text{-}1.5),\ \text{HP}(t1)} = \text{-}0.001$, *s.e.* < 0.001, $p = .005$).

Sensitivity Analyses

The final bivariate ALT-model including the zero imputed variable of formal home practice (i.e., missing calendar meaning no formal home practice performed) on the same sample as the primary analysis ($n = 200$) yielded similar results, except that some effects became non-significant. This included the CL effects from formal home practice to subsequent depressive symptoms ($b_{\text{HP}(t\text{-}1.5),\ \text{DEP}(t1)} = 1.971$, *s.e.* = 1.573, $p = .210$) and the AR effect between depressive symptoms at 12 and 15 months of follow-up ($\rho\text{AR}_{\text{DEP}(t12),\ \text{DEP}(t15)} = -.211$, *s.e.* = 0.112, $p = .060$). These results were also found when fitting the final bivariate ALT model with the zero imputed variable of formal home practice including all participants randomized to MBCT ($n = 282$).

Discussion

The current study used autoregressive Latent Trajectory (ALT) modelling to investigate the prospective associations between formal home practice frequency and depression severity during 15 months of follow-up in recurrently depressed patients participating in MBCT. Overall trajectories showed a rapid decline of formal home practice frequency and a stable course of depressive symptoms over time. The hypothesis that more frequent formal home practice would lead to reductions in depressive symptoms was not confirmed in the current study. In contrast, we found a small effect of more practice being associated with higher levels of subsequent depressive symptoms. However, this was not confirmed by both sensitivity analyses. The current

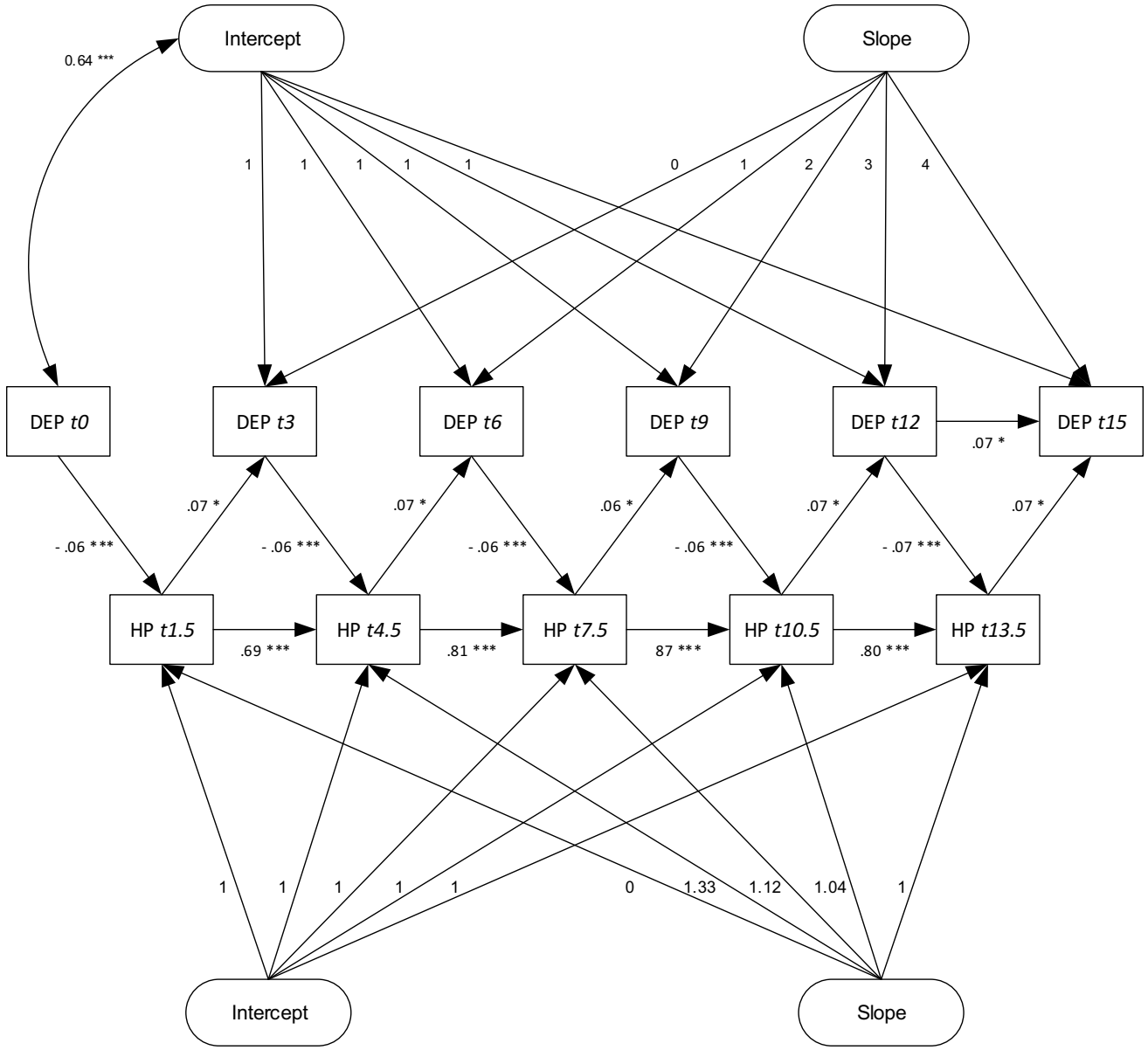

Fig. 3 Standardized parameter estimates of the final bivariate ALT model. Significant estimates are depicted by solid black lines, non-significant estimates are not shown. Double-headed arrows represent correlations. The 2nd, 3rd, and 4th factor loadings of the slope factor of formal home practice were freely estimated. The autoregressive effects of formal home practice were set equal to each other; the same applies to the cross-lagged effects of formal home practice to depressive symptoms, and from depressive symptoms to formal home practice. Note that standardizing the parameters may disrupt the equality constraints. *t0* = baseline; *t1.5* = 1–3 months; *t3* = 3 months; *t4.5* = 4–6 months; *t6* = 6 months; *t7.5* = 7–9 months; *t9* = 9 months; *t10.5* = 10–12 months; *t12* = 12 months; *t13.5* = 13–15 months; and *t15* = 15 months of follow-up. *DEP* depressive symptoms, *HP* formal home practice

study did find support for a reversed effect; patients with higher levels of depression subsequently performed formal exercises less frequently at home.

Non-compliance with formal home practice remains a persistent problem in clinical practice. The overall formal home practice compliance rate of the current study during MBCT (57%) was slightly lower compared to rates found by Parsons et al. (2017), who reported a pooled estimate of 64% (95% CI 60–69%) of what is typically suggested in MBCT/MBSR formats (Kabat-Zinn 1990; Segal et al. 2012). Moreover, compliance rates rapidly declined after the intervention period, which is in line with previous research (Bondolfi et al. 2010). The finding that depressive symptoms did not decrease over the study period might be inherent to the participants included in the current study, namely patients in remission at start of the study.

Against expectations, no robust associations between formal home practice frequency and subsequent reduction of depressive symptoms were found. This is in contrast to previous research suggesting that more formal home practice during MBCT/MBSR is associated with better posttreatment outcomes (Parsons et al. 2017; Van Aalderen et al. 2012) and reduced long-term relapse/recurrence rates (Crane et al. 2014) in recurrently depressed patients. The relatively low average frequency of formal home practice and the rapid decline of formal home practice frequency after the intervention period might have resulted in the marginal to non-significant findings of the current study. In addition, the relative stability of the outcome measure over time may have resulted in a restriction of range. More pronounced effects of formal home practice on depressive symptoms might be found when MBCT targets acutely depressed individuals. On the other hand, based on the findings of the current study, higher levels of depression might actually impede formal home practice itself.

Support for a reversed effect was found in the current study. Patients with more depressive symptoms subsequently performed formal exercises less frequently at home. As previous studies investigating the association between formal home practice and outcome were mostly correlational (Parsons et al. 2017) and to our knowledge, a reverse effect has not yet been investigated, this might shed a new light on the association between formal home practice and depressive symptoms in MBCT for recurrent depression. One possible interpretation could be that difficulties with motivation and concentration, or a tendency to avoid negative thoughts, feelings and possibly bodily sensations, might make it more challenging to engage in mindfulness practice. Qualitative research into the specific barriers and facilitators to engage in mindfulness practice could provide more insight in the underlying processes.

The current study addresses two important gaps in the literature on MBCT home practice and depression outcomes (Parsons et al. 2017). First, by using ALT modelling techniques, we were able to disentangle the dynamic relationship between formal home practice frequency and depression severity over time. Second, by including long-term follow-up data, we were able to gain more insight into this relationship beyond the intervention period. In addition, a continuous outcome measure was used, allowing more subtle changes to be detected compared with a binary measure (e.g., relapse). Moreover, the data in this study was drawn from two multi-center RCTs, in which MBCT was delivered in university hospitals and community mental health centers across The Netherlands. Therefore, this study has drawn a rather realistic picture of compliance in patients from secondary and tertiary care with recurrent depression with mild levels of depressive symptoms.

Of course, the current study is not without limitations. At first, selection bias might have taken place because 82 participants were excluded from the primary analyses in the current study due to missing data on formal home practice. We handled this by performing sensitivity analyses with zero imputation (i.e. no calendar data meaning no home practice) both on the same data set, as well as on the data of all participants randomized to MBCT. In addition, the primary excluded patients did not differ on baseline characteristics and depression outcomes compared to the included patients, however, they may differ in other aspects that are related to adherence that were not assessed in the current study. Second, the analyses presented in the current study did not correct for individuals tapering off their antidepressant medication (tADM) nor teacher competency/experience, because running a conditional bivariate ALT-full model including tADM did not affect results and led to a decrease in model fit. In addition, previous research on the same dataset by Huijbers et al. (2017) found that teacher competency/experience was not associated with MBCT treatment outcomes (e.g., depressive symptoms). However, other possible confounding factors that were not assessed cannot be ruled out (e.g., childhood trauma). Third, a methodological limitation is that the current study was observational in terms of formal home practice and outcomes and did not manipulate formal home practice as a predictor. Random assignment of participants in MBCT with or without experiential cultivation of mindfulness practice (including home practice) has been previously done by Williams et al. (2014), who compared MBCT with both cognitive psychological education (CPE) and treatment as usual (TAU) in preventing relapse to MDD in people currently in remission. CPE was modeled on MBCT, but without experiential training in meditation. MBCT provided significant protection against relapse for participants with increased vulnerability due to history of childhood trauma, but showed no significant advantage in comparison to CPE or usual care over the whole group of patients with recurrent depression. Lastly, a limitation of the current study is that the effect of informal home exercises was not included. Informal exercises are typically shorter exercises that bring present-moment awareness into everyday activities (e.g., consciously performing a daily routine activity). Perhaps over time, formal home practices are used less frequently, while informal exercises become more embedded in participants' daily life (Bondolfi et al. 2010). However, it seems challenging to quantify the frequency and duration of informal exercises due to their more integrated nature, as a result of which they have been studied less often (Vettese et al. 2009). Research to date did not find associations between informal home exercises in MBCT/MBSR in patients with recurrent depression and intervention outcomes (e.g., Bondolfi et al. 2010; Crane et al. 2014; Hawley et al. 2014).

For future studies, it is important to operationalize home practice, both formal and informal, in the same way across studies and to avoid drop-out as much as possible. Improving the methodology, the use of smartphone applications to record real-time home practice and outcomes could be a great way forward. Data on both frequency and amount of time spend on each practice can easily be collected in this way. In addition, next to negative outcome measures, it would be valuable to include repeatedly administered positive health measures (e.g., quality of life, positive mental health). Moreover, notes on the quality of practice could be collected, which may be another relevant aspect of the relation between practice and outcomes (Del Re et al. 2013; Goldberg et al. 2019). Finally, qualitative in-depth interviews could provide valuable information about the views that people have on the importance of regular practice, and about specific barriers and facilitators that affect the engagement in mindfulness practices.

In conclusion, the interplay between home practice and outcome might not be as straightforward as expected. The current study shows support for depressive symptoms to have a negative influence on home practice, but not the other way around. However, these results are preliminary and should be replicated first before recommendations for clinical practice can be formulated.

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Data Availability The data analysed in the current study are available from the corresponding author on reasonable request.

Compliance with Ethical Standards

Conflict of Interest Marleen J. ter Avest, Corina U. Greven, Tom F. Wilderjans, Marloes J. Huijbers, Anne E. M. Speckens and Philip Spinhoven declare that they have no conflict of interest.

Ethical Approval All procedures performed involving human participants were in accordance with the ethical standards of the research committee Medical Ethics Committee of Arnhem-Nijmegen, CMO (No. 2008/242) and with the 1964 Helsinki declaration and its later amendments.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Animal Rights No animal studies were carried out by the authors for this article.

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